BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: CM-SM/LM-ATM Alternate Mission Study Case 620

DATE: June 6, 1968

FROM: G. M. Anderson

ABSTRACT

Alternatives to the AAP baseline Cluster Mission for the ATM are possible. The configuration docks the CM-SM to the LM-ATM.

A work plan to

1. develop the properties of the Alternate Mission, and
2. determine the backup mission capability using the prime hardware

is presented.

Parametric data on attainable orbital altitides for 14, 28 and 56 day missions at 28 1/2°, 50° and 63.5° inclination will be developed. For these orbits, total solar viewing and continuous solar viewing times will be generated.

Continued effort to establish a consensus on criteria for judging relative scientific yield for mission alternatives is planned.

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MEMORANDUM FOR FILE

INTRODUCTION

Current plans for the AAP solar astronomy mission dock the LM-ATM and CM-SM to the Orbital Workshop in a clustered configuration. Alternatives to the primary mission exist in which the CM-SM and LM-ATM are flown independently of the Workshop. Freedom from Workshop orbital altitude and inclination constraints and launch time constraints have suggested the possibility that the Alternate Mission concept may be optimized to achieve a greater scientific yield than the Cluster Mission. It is proposed here that the merits of this option be developed. An outline of a proposed work plan is presented. A preliminary version of the plan was discussed with astronaut O. K. Garriott/MSC, H. Glaser/SG and D. L. Forsythe/MLA at NASA Headquarters May 31, 1968.

Missions in which the CM-SM and LM-ATM are not docked to the Workshop are called decoupled missions. Alternate Missions are a restricted class of decoupled missions in which the decision not to use the Workshop is made prior to the launch of both the CM-SM and the LM-ATM. Missions in which the decision to fly decoupled is made subsequent to the launch of either the CM-SM or LM-ATM are known as Contingency Missions. This memorandum and the proposed study are limited to Alternate Missions.

The study is to serve two separate but related purposes. It will

1. develop the properties of the Alternate Missions, and

2. determine the ability of the system to fly a backup mission using the prime hardware in the event the Cluster Mission cannot be flown.

It is not obvious that these two objectives can be served by a single study. From a purely logical standpoint, it is necessary to choose between the Cluster and Alternate Mission in order to optimize.

Preliminary analysis indicates that the system requirements, particularly for LM-A, do not differ greatly for the Alternate and Cluster Missions. The weight penalties for maintaining LM-A propulsion capability are not severe. The ability of the LM-A strucutre to support an SPS thrusting maneuver in the docked CSM/LM-ATM configuration is emerging as a baseline requirement.

Dixon Forsythe urged that the study treat the Cluster Mission as primary. Since the penalties for the Alternate Mission associated with making the Cluster Mission prime are not large, Mr. Forsythe's recommendation was accepted.

ASSUMPTIONS AND CONDITIONS

1. Saturn I-B launch system will be used.

2. Mission Duration. Three cases will be studied - 14 days; 28 days; 56 days.

3. AAP Standard CM-SM.

   a. Average Power Level of 2.8 KW.

   b. ATM Solar Array will provide 1 KW average electrical power to the CM-SM. The fuel cells deliver 1.8 KW.

   c. Weight - Including crogens and 10 days supply of LiOH.

14 days	24,900 lbs.
28 days	26,350 lbs.
56 days	28,794 lbs.

   These weights do not include:

   Useable SPS.
   RCS quantities except for 10 lbs/day for desaturation.
   RCS tank capacity is 3670 lbs total.
   SLA - 3815 lbs.

   The CM-SM weights for 14 and 28 day missions reflect the savings in cryogenic tankage possible for the reduced mission duration. A two gas atmosphere is retained.

4. LM-ATM

   a. LM-A Baseline.

   b. Primary Battery Capacity - Retain LM-A PRR configuration, 30 kwhr.

      Assume four days of LM-ATM life from launch to docking of CM-SM.

   c. Launch Vehicle must also orbit:

      SLA - 1380 lbs.
      LV Modifications - 750 lbs.

   d. Weight - Includes LiOH for duration over 10 days.

14 days	25,700 lbs.
28 days	25,800 lbs.
56 days	26,100 lbs.

      RCS propellant is not included.

5. Mission Modes

   Maximum performance is desired.

   Spacecraft propulsion maneuvers are necessary.

   LM-ATM launch is first.

   No Solar Array Deployment prior to CM-SM docking.

   2 1/2 stages to orbit*

   Two Cases:

      a. CM-SM/LM-ATM rendezvous in relatively low altitude orbit. SM SPS is used either once or twice in a Hohmann maneuver to obtain the final elliptical or circular orbit.

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* This unusual designation has been applied to an SPS burn of the SM during the launch phase. S-IVB does not orbit in this mode.

b. LM-A RCS is used in single or double burn in conjunction with corresponding but separate SPS burns to obtain final orbit. Rendezvous is in the final orbit.

Deorbit is with the SPS. Backup deorbit uses an SM RCS burn at apogee.

Two cases are desired:

a. 10g limit

b. low g limit.

WORK OUTLINE

1. Performance

   a. Feasible Missions for specified payloads and duration.

   b. Impact data for S-I and S-IVB stages.

   c. Abort delay time for elliptical cases.

   d. Landing Point data for backup deorbit.

2. Solar Viewing

   For feasible missions:

   a. Total Solar Viewing Time as function of date and time of launch and location of apogee.

   b. Maximum continuous viewing time as a function of date and time of launch and location of apogee.

   Atmospheric Height - 150 km. Consideration will be given to the special requirements of the coronograph experiment with respect to look angles above the horizon to achieve adequately low background.

3. Guidance and Control

   a. Preliminary assessment of ability of S-IVB to support yaw maneuvers.

b. Preliminary assessment of impact of ability of CM-SM to support SPS burn docked to LM-A.

c. Preliminary assessment of the ability of CM-SM and LM-A systems to support rendezvous and docking requirements.

4. Attitude Control

CMG desaturation fuel requirements.

Frequency of desaturation operations.

Preliminary assessment of ability of pointing control system to meet accuracy requirements.

5. Computer Systems

a. Impact on MCC-H and KSC computer systems hardware and software.

b. Impact on Launch Vehicle Digital Computer, Command Module Computer, and LM Guidance Computer hardware and software.

6. Communications and Tracking

a. Coverage for feasible missions.

b. Coverage during propulsive maneuvers.

7. Radiation

Dose calculations for feasible missions for

Man
Film

8. Meteoroid Environment

Reliability determination for CM, SM and LM-A.

9. Electrical Power

Electrical power which can be supplied to CM-SM for selected orbits. The maximum requirement is 1.6 KW if fuel cells are maintained at water making level (1.2 KW). If it appears desirable, the data developed under (1) and (2) in this section can be optimized using the lower cryo loadings associated with the 1.2 KW CSM fuel cell level.

10. Structure

LM-A modifications to support the SPS thrusting maneuver.

Impact of SM propulsive maneuver on ATM design.

Impact of S-IVB yaw maneuver on ATM design.

11. ATM Experiments

Liason with the Principal Investigators, NASA/SG, MSFC and other cognizant elements of the scientific community will be continued. The criteria of importance in evaluating the merits of mission alternatives will be identified.

12. Schedule

Vu-graph presentation material - July 12, 1968.

Final Written Report - July 26, 1968.

G. M. Anderson

1022:GMA:ms

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